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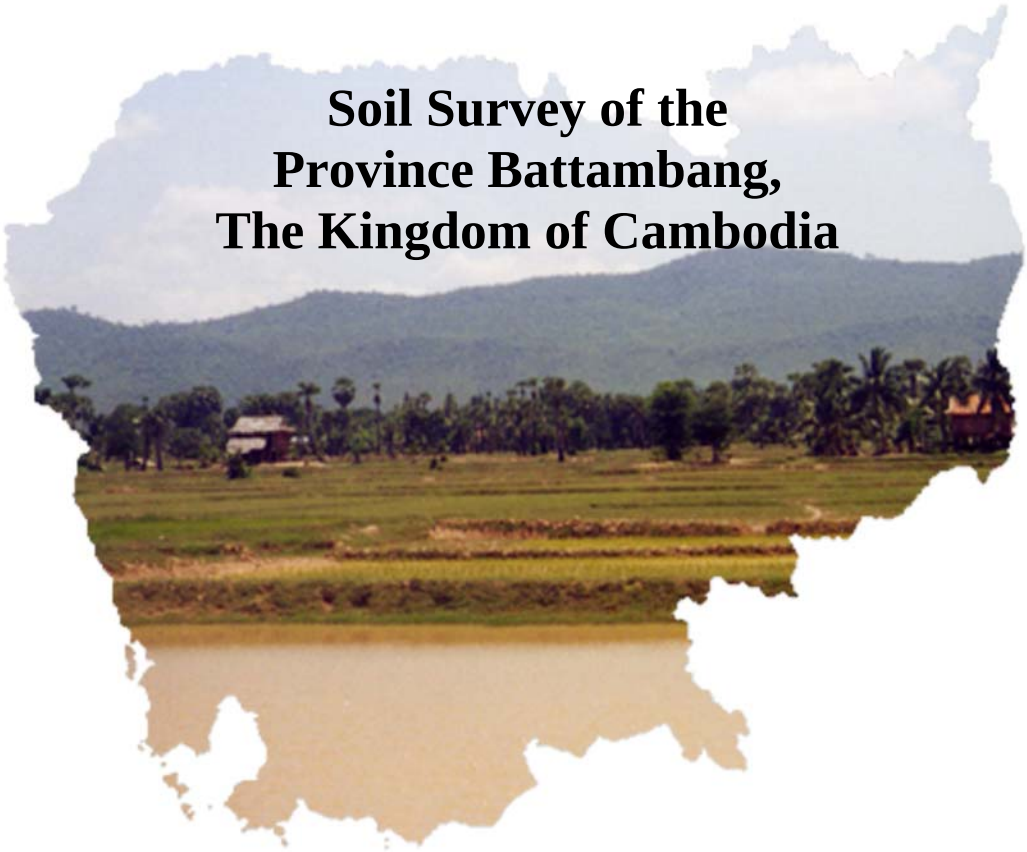
Technical Report No. 13
Soil and Water Sciences Division

Soil Survey of the Province Battambang, The Kingdom of Cambodia



June 2007. Phnom Penh. Cambodia

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Soil Survey of the Province Battambang, The Kingdom of Cambodia

Covering the District of Banan with additional soil profiles from the Districts of Kamrieng, Phnum Proek, Thma Koul and Rotanak Mondol.

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ACIAR Project No. LWR1/2001/051
Assessing Land Suitability for Crop Diversification in Cambodia and Australia

June 2007. Phnom Penh. Cambodia

Introduction

From 2003 to 2005 soil surveys were completed in the Kingdom of Cambodia as part of a collaborative project between the Cambodian Agricultural Research and Development Institute (CARDI), Murdoch University and Department of Agriculture and Food Western Australia. The project was funded by the Australian Centre for International Agricultural Research.

This report provides the results of soil profile descriptions and soil chemical analysis completed in the Province of Battambang (Figure 1). Most of the soil profiles in this report are from the District of Banan with additional soil profiles from the Districts of Kamrieng, Phnum Proek, Thma Koul and Rotanak Mondol. The locations of soil profiles in this report have been georeferenced and are shown overlaid on a Landsat mosaic image (Figure 2) (images collected from 1989 to 1994; Source for this dataset was the Global Land Cover Facility, http://www.landcover.org.).

Materials and Method

Soil Profile Description

Soil profiles were described using a combination of codes and definitions from the Food and Agriculture Organisation and the Department of Agriculture and Food Western Australia (FAO-ISRIC 1990; Purdie 1999; FAO-CSIC 2002). These codes and descriptions were compiled into a booklet entitled 'Dataset and Code Definitions for the Soil Survey of Cambodia'. A data sheet for recording soil profile information at each site was also produced. Soil profiles were classified using the Cambodian Agronomic Soil Classification (CASC) (White et al. 1997) and World Reference Base for Soil Resources (IUSS 2006).

Soil Chemical Analysis

Laboratory analysis was completed on all horizons for a selection of the soil profiles. These soil samples were analysed by CSBP laboratories in Western Australia. All soil samples were air-dried, ground and sieved (<2 mm particle diameter). The following tests were used *(i)* electrical conductivity and pH in 1:5 soil:water suspension and pH in 0.01M $CaCl_2$ (Rayment and Higginson 1992, pp15-23); *(ii)* organic carbon concentrations, (Walkley and Black 1934); *(iii)* concentration of exchangeable cations, Gilman and Sumpter method (Rayment and Higginson 1992, pp 164-169); *(iv)* DPTA trace elements (copper, Cu; zinc, Zn; manganese, Mn; iron, Fe) (Rayment and Higginson 1992, pp 110-114); *(v)* nitrate and ammonium nitrogen (Searle 1984); *(vi)* available phosphorus and potassium, Colwell method (Rayment and Higginson 1992, p 64); *(vii)* extractable sulphur (Blair et al. 1991); (viii) boron (Rayment and Higginson 1992, pp 115-120). The soil chemical data can be found in Tables 1 to 3 at the end of this report.

Data Collection and Reporting

For each soil profile, location information was collected using a hand held GPS. This has enabled mapping of the data, and will enable users of the data in the field to return to soil profile locations. All soil profile data has been placed into an Access database currently maintained by the Soil and Water Group at CARDI. Other districts included in this study were Ou Reang Ov in the Province of Kampong Cham and Tram Kak in the Province of

Takeo. Results of these surveys can be found in soil survey reports for each district. In addition the results of these soil surveys have been used to generate soil-land unit maps of each district (Hin et al. 2005a,b,c) and assist in the assessment of land capability for field crops in each district (Bell et al. 2005a,b).

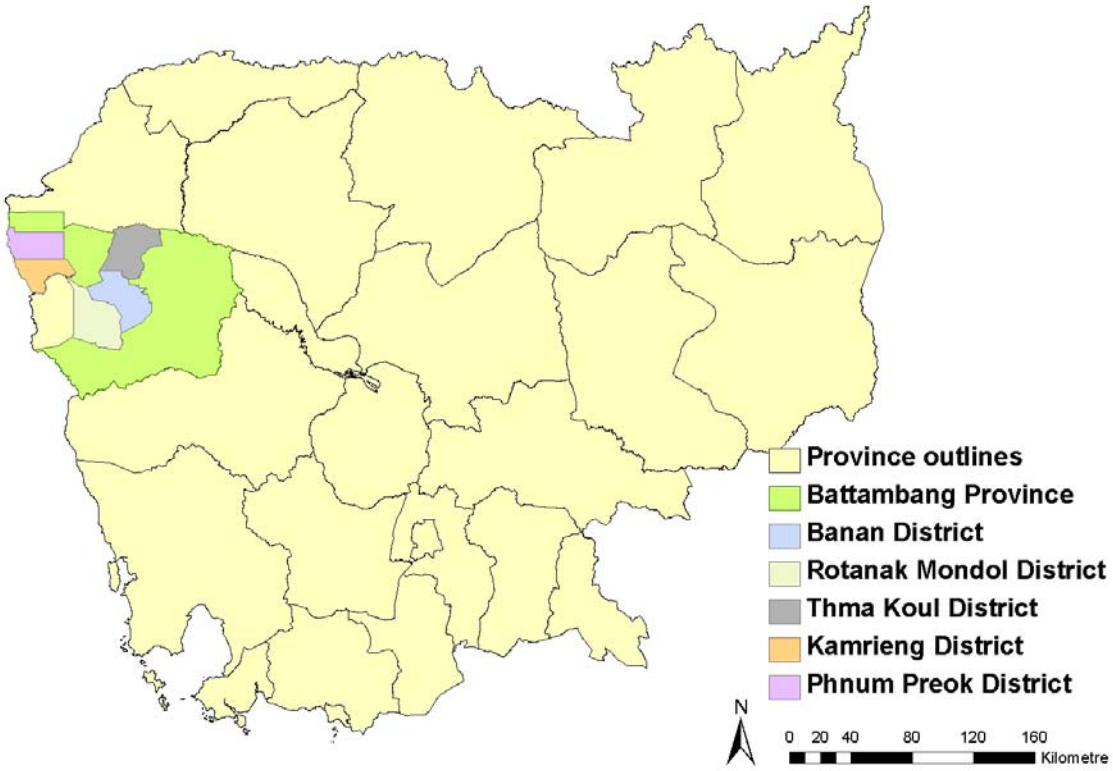

Figure 1. Province of Battambang and Districts within where soil profiles were analysed.

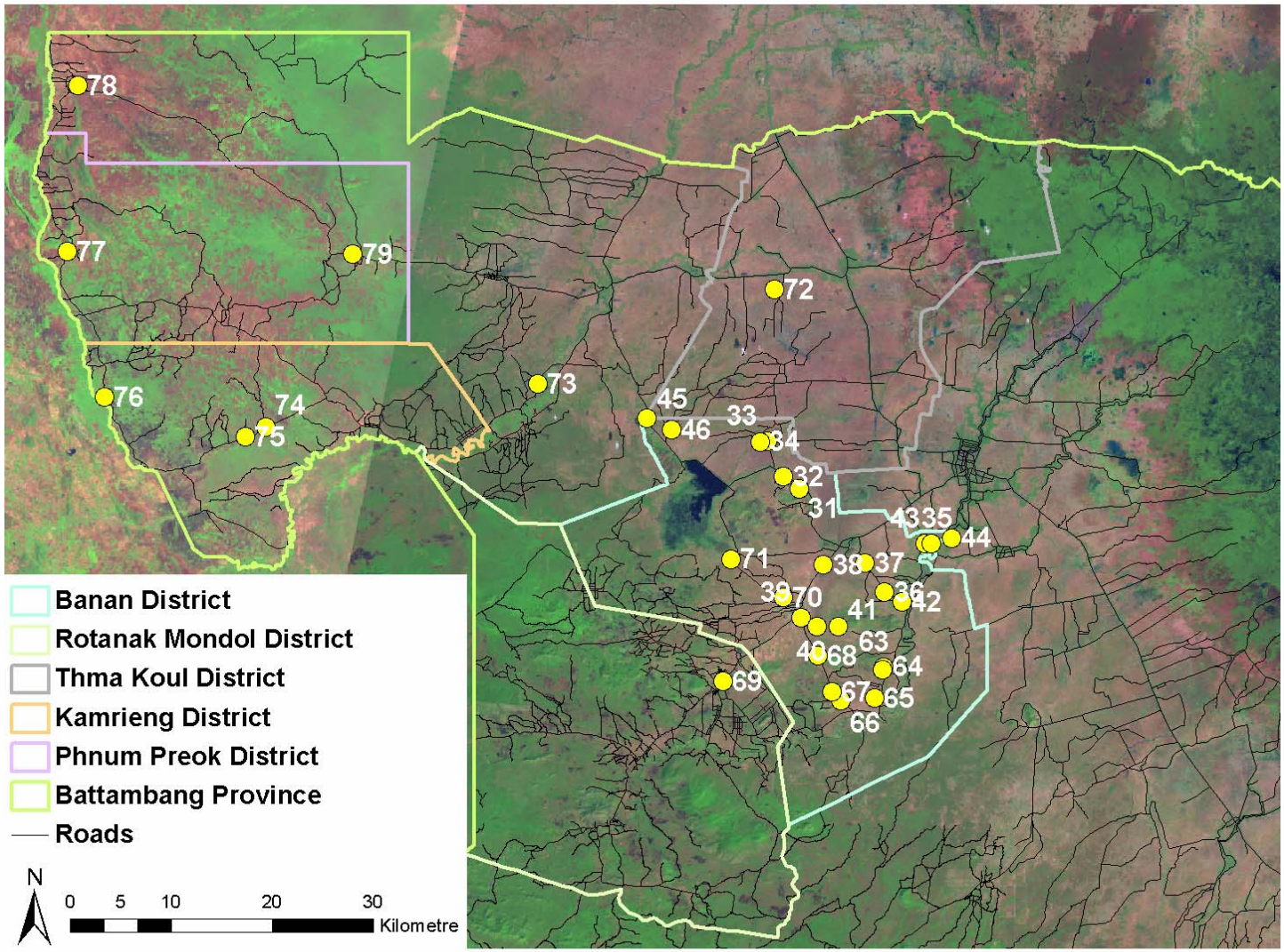

Figure 2. Soil survey sites in the Province of Battambang

Project & Site Code: ACIAR 0031 **Described by:** Schoknecht Noel
Date: 4/2/2004

Observation type/category: soil pit, full description

Location: Datum: IND60 Zone: 48 288761 mE 1445515 mN GPS measurement

Province: BATTAMBANG **District:** Banan
Commune: Ta Kream **Village:** Thmei

Site notes: Soil classifies as Kompong Siem, but very different to soil in basalt in Kampong Cham Province
Disturbance: ploughing
Trials completed: MWS 2004, MWS 2005

Landform
Landform element: slope
Landform pattern: pediment
Relief/modal slope: low-gradient footslope
Slope class: gently sloping, 2-5%
Morphological type: lower slope
Slope curvature: straight
Microrelief: uneven

Surface and Hydrological Properties
Physical properties: surface crust

Geology/parent material
Soil parent material: limestone, other carbonate rock
Notes: Limestone colluvium
Geology: limestone, other carbonate rock

Land use
Site: rainfed arable cultivation
Surrounds: rainfed arable cultivation

Current Classification
World Reference Base: (2006) Calcic Chernozem (clayic)
Local Soil Name: Kompong Siem, non gravelly phase

Project & Site Code: ACIAR 0031 **Described by:** Schoknecht Noel
Date: 4/2/2004

Soil Profile Description

Horizon	Depth (cm)	Description
A1t	0-8	very dark grey (2.5YR 3/0 moist) clay ; hard dry consistence; pedal, moderate, subangular blocky structure; rough-ped fabric; no segregations; many roots, very fine, non-cemented and non-compacted; common, fine and medium, medium porosity, vughs void; clear, smooth boundary.
A2t	8-30	very dark grey (2.5YR 3/0 moist) heavy clay; firm moist consistence; pedal, moderate, medium, subangular blocky structure; rough-ped fabric; very few segregations, very fine carbonates (calcareous) nodule rounded white hard; few roots, very fine, non-cemented and non-compacted; gradual, wavy boundary.
ACk	30-45	dark grey (5YR 4/1 moist) clay; firm moist consistence; pedal, weak, medium, subangular blocky structure; rough-ped fabric; many segregations, very fine carbonates (calcareous) nodule rounded white both hard and soft; no roots, non-cemented and non-compacted; abrupt, wavy boundary.
Ck	45-100+	pinkish grey (5YR 7/2 moist) clay; medium faint reddish brown (5YR 4/3 moist) biological mottles; friable moist consistence; weak, medium, subangular blocky structure; dominant segregations, fine carbonates (calcareous) nodule rounded white both hard and soft; no roots, non-cemented and non-compacted.

Project & Site Code: ACIAR 0032 **Described by:** Schoknecht Noel
Date: 4/2/2004

Observation type/category: auger boring, brief description

Location: Datum: IND60 Zone: 48 287213 mE 1446779 mN GPS measurement

Province: BATTAMBANG **District:** Banan
Commune: Ta Kream **Village:** Thmei

Site notes: Same soil as site 31, but deeper to lime layer
Disturbance: ploughing
Trials completed: EWS 2004, EWS 2005

Landform
Landform element: slope
Landform pattern: pediment
Slope class: very gently sloping, 1-2%
Microrelief: uneven

Surface and Hydrological Properties
Rock outcrop: no rock
Surface coarse fragments: no gravel
Physical properties: cracking surface

Vegetation
Crop: rice

Land use
Site: rainfed arable cultivation *Surrounds:* rainfed arable cultivation

Current Classification
World Reference Base: (2006) Calcic Chernozem (clayic)
Local Soil Name: Kompong Siem, non gravelly phase

Project & Site Code: ACIAR 0032 **Described by:** Schoknecht Noel
Date: 4/2/2004

Soil Profile Description

Horizon	Depth (cm)	Description
A1t	0-24	very dark grey (5YR 3/1 moist) clay; very hard dry consistence; weak structure.
A2t	24-61	dusky red (2.5YR 3/1 moist) heavy clay; firm moist consistence; very few segregations, very fine carbonates (calcareous) nodule rounded white hard.
ACk	61-75	dark grey (5YR 4/1 moist) clay; firm moist consistence; many segregations, very fine carbonates (calcareous) nodule rounded white both hard and soft.
Ck	75-90+	light grey (10YR 7/2 moist) clay; friable consistence; dominant segregations, fine carbonates (calcareous) nodule rounded white both hard and soft.

Project & Site Code: ACIAR 0033 **Described by:** Schoknecht Noel
Date: 4/2/2004

Observation type/category: soil pit, full description

Location: Datum: IND60 Zone: 48 285603 mE 1450277 mN GPS measurement

Province: BATTAMBANG **District:** Banan
Commune: Ta Kream **Village:** Prey Phdau

Site notes: Cracking clay - Vertisol
Disturbance: ploughing

Landform
Slope class: nearly level, 0.5-1%

Surface and Hydrological Properties
Physical properties: cracking surface

Land use
Site: rainfed arable cultivation *Surrounds:* shifting cultivation

Current Classification
World Reference Base:(2006) Mollic Vertisol (calcaric)
Local Soil Name: Kompong Siem, non gravelly phase

Project & Site Code: ACIAR 0033 **Described by:** Schoknecht Noel
Date: 4/2/2004

Soil Profile Description

Horizon	Depth (cm)	Description
A1	0-3	very dark grey (5YR 3/1 moist) clay; very hard consistence; strong, medium, granular structure; very few segregations, fine carbonates (calcareous) nodule rounded white hard; many roots, fine; common, fine, vughs void; sharp, wavy boundary.
A2t	3-30	very dark grey (7.5YR 3/0 moist) heavy clay; extremely hard consistence, sticky; strong, very coarse, angular and subangular blocky structure; dominant segregations, fine carbonates (calcareous) nodule rounded white both hard and soft; common roots, fine; few, fine, vughs void; clear, wavy boundary.
AB	30-60	dark greyish brown (10YR 4/2 moist) clay; firm consistence, sticky; moderate, coarse, angular and subangular blocky structure; very few segregations, fine carbonates (calcareous) nodule rounded white hard; few roots, fine; common, fine, vughs void; gradual, wavy boundary.
B	60-100	dark greyish brown (10YR 4/2 moist) clay; firm consistence, sticky; strong, coarse, angular blocky structure; many segregations, fine carbonates (calcareous) nodule rounded white both hard and soft; no roots; few, fine, vughs void; abrupt, wavy boundary.
BC	100-110+	white (2.5Y 8/2 moist) clay; firm consistence; massive structure; common segregations, fine carbonates (calcareous) nodule rounded white both hard and soft; no roots; few, fine, vughs void.

Project & Site Code: ACIAR 0034 **Described by:** Schoknecht Noel
Date: 4/2/2004

Observation type/category: soil pit, full description

Location: Datum: IND60 Zone: 48 284860 mE 1450240 mN GPS measurement

Province: BATTAMBANG **District:** Banan
Commune: Ta Kream **Village:**

Site notes: Gently undulating alluvial plain next to small creek
Trials completed: MWS 2004, MWS 2005

Landform
Landform pattern: alluvial plain
Relief/modal slope: plain
Slope class: nearly level, 0.5-1%

Surface and Hydrological Properties
Surface coarse fragments: no gravel
Physical properties: cracking surface

Geology/parent material
Soil parent material: fluvial
Notes: clayey alluvium

Land use
Site: rainfed arable cultivation
Surrounds: rainfed arable cultivation

Current Classification
World Reference Base:(2006) Haplic Vertisol (mesotrophic)
Local Soil Name: Toul Samroung, brown phase

Project & Site Code: ACIAR 0034 **Described by:** Schoknecht Noel
Date: 4/2/2004

Soil Profile Description

Horizon	Depth (cm)	Description
A1	0-10	brown (7.5YR 4/2 moist) clay loam; fine distinct mottles; hard dry consistence; weak, fine, subangular blocky structure; many roots, very fine; no coarse fragments; moderate permeability; medium porosity void; sharp, smooth boundary.
A2	10-40	brown (7.5YR 5/2 moist), pinkish grey (7.5YR 6/2 dry) clay; fine distinct brown (7.5YR 4/4 moist) redox mottles; slightly hard dry consistence; moderate, fine, subangular blocky structure; very few segregations, fine manganese (manganiferous) concretion rounded soft; common roots, fine; no coarse fragments; rapid permeability; medium porosity void; clear, wavy boundary.
B1t	40-80	pinkish grey (7.5YR 6/2 moist) heavy clay; reddish brown (2.5YR 4/4 moist) redox mottles; firm moist consistence, sticky; moderate, medium, angular and subangular blocky structure; few segregations, fine manganese (manganiferous) concretion rounded soft; few roots, fine; no coarse fragments; slow permeability; very low porosity void; gradual, wavy boundary.
B2t	80-100+	pinkish grey (7.5YR 6/2 moist) heavy clay; fine distinct red (2.5YR 4/6 moist) redox mottles; firm moist consistence, sticky; moderate, medium, angular and subangular blocky structure; few segregations, fine manganese (manganiferous) concretion rounded soft; few roots; no coarse fragments; slow permeability; very low porosity void.

Project & Site Code: ACIAR 0035 **Described by:** Schoknecht Noel
Date: 5/2/2004

Observation type/category: soil pit, full description

Location: Datum: IND60 Zone: 48 301268 mE 1440063 mN GPS measurement

Province: BATTAMBANG **District:** Banan
Commune: Chheu Teal **Village:** Khnar

Site notes: Soil pit and trial site. Soil transitions to Kein Svay soil group.
Trials completed: EWS 2004, EWS 2005

Landform
Landform pattern: alluvial plain
Slope class: level, 0.2 - 0.5%

Surface and Hydrological Properties
Physical properties: cracking surface

Geology/parent material
Soil parent material: fluvial

Land use
Site: rainfed arable cultivation *Surrounds:* rainfed arable cultivation

Current Classification
World Reference Base:(2006) Haplic Vertisol (mesotrophic)
Local Soil Name: Toul Samroung, brown phase

Project & Site Code: ACIAR 0035 **Described by:** Schoknecht Noel
Date: 5/2/2004

Soil Profile Description

Horizon	Depth (cm)	Description
A	0-10	brown (10YR 4/3 moist) clay; firm dry consistence; pedal, moderate, medium, subangular blocky structure; rough-ped fabric; common roots, fine; clear, smooth boundary.
Bt	10-50	dark greyish brown (10YR 4/2 moist) clay; fine faint strong brown (7.5YR 5/6 moist) redox mottles; firm moist consistence; pedal, strong, coarse, subangular and angular blocky structure; rough-ped fabric; few roots, fine; gradual, wavy boundary.
BC	50-85	dark greyish brown (10YR 4/2 moist) clay; fine distinct strong brown (7.5YR 5/6 moist) redox mottles; firm moist consistence; pedal, weak, coarse, angular and subangular blocky structure; rough-ped fabric; few segregations, fine manganese (manganiferous) concretion irregular soft; few roots, fine; diffuse, wavy boundary.
C	85-130+	brown (10YR 5/3 moist) sandy clay loam; medium distinct strong brown (7.5YR 4/6 moist) redox mottles; friable moist consistence; common segregations, fine manganese (manganiferous) concretion irregular soft; no roots.

Project & Site Code: ACIAR 0042 **Described by:** Schoknecht Noel
Date: 6/2/2004

Observation type/category: soil pit, full description

Location: Datum: IND60 Zone: 48 298956 mE 1434258 mN GPS measurement

Province: BATTAMBANG **District:** Banan
Commune: Chheu Teal **Village:**

Site notes: Good alluvial soil - brown and few mottles. 700m from Sang Kae River
Trials completed: MWS 2004, EWS 2005

Landform
Landform pattern: alluvial plain
Relief/modal slope: plain
Slope class: nearly level, 0.5 - 1.0 %

Surface and Hydrological Properties
Rock outcrop: no rock
Surface coarse fragments: no gravel
Physical properties: firm surface; moderately well drained; >150 soil

Geology/parent material
Soil parent material: fluvial
Note: Clayey alluvium

Vegetation
Notes: chilli, last crop

Land use
Site: rainfed arable cultivation *Surrounds:* rainfed arable cultivation

Current Classification
World Reference Base:(2006) Haplic Cambisol (clayic)
Local Soil Name: Kein Svay, no phase specified

Project & Site Code: ACIAR 0042 **Described by:** Schoknecht Noel
Date: 6/2/2004

Soil Profile Description

Horizon	Depth (cm)	Description
A	0-16	brown (7.5YR 4/3 moist) clay loam; no mottles; hard consistence; pedal, moderate, fine, subangular blocky structure; rough-ped fabric; no segregations; many roots, fine.
B	16-60	brown (7.5YR 4/2 moist) clay; no mottles; firm consistence; pedal,; smooth-ped
BC	60-110+	brown (7.5YR 4/2 moist) clay; common fine faint light brown (7.5YR 6/4 moist) redox mottles; firm consistence; pedal,; smooth-ped fabric; many segregations, fine manganese (manganiferous) rounded black soft; many roots, medium.

Project & Site Code: ACIAR 0063 **Described by:** Schoknecht Noel
Date: 18/05/2005

Observation type/category: auger boring, observation

Location: Datum: IND60 Zone: 48 297111 mE 1427803 mN GPS measurement

Province: BATTAMBANG **District:** Banan
Commune: Kantueu Muoy **Village:** Sasar Pok

Site notes: This soil does not fit within Cambodian Agronomic Soil Classification well. It is most like Kompong Siem, but there are no rocks in the profile and it is not deeply cracking. Has carbonates in subsoil.
Disturbance: ploughing

Landform
Landform element: slope *Landform pattern:* pediment
Relief/modal Slope: low-gradient footslope *Slope class:* gently sloping 2-5%
Morphological type: Lower slope *Slope curvature:* straight

Surface and Hydrological Properties
Physical properties: surface crust surface

Vegetation
Crop: peanut (groundnut)
Notes: Cleared. Peanut grow well, but doesn't set fruit.

Current Classification
World Reference Base: (2006) Gramic Vertisol (mesotrophic)
Local Soil Name: Kompong Siem, non gravelly phase

Soil Profile Description

Horizon	Depth (cm)	Description
Ap	0-12	very dark greyish brown (10YR 3/2 moist) silty clay; no mottles; friable moist consistence, plastic; strong, fine, granular structure; moderate permeability; abrupt, smooth boundary.
B1	12-40	greyish brown (10YR 5/2 moist) clay; common fine faint yellowish red (5YR 4/6 moist) mottles; very firm moist consistence, plastic; strong, coarse, subangular blocky structure; slow permeability; gradual boundary.
B2	40-90+	grey (10YR 5/1 moist) clay; firm moist consistence, very plastic; slow permeability.

Project & Site Code: ACIAR 0064 **Described by:** Schoknecht Noel
Date: 18/05/2005

Observation type/category: soil pit, brief description

Location: Datum: IND60 Zone: 48 297051 mE 1427549 mN GPS measurement

Province: BATTAMBANG **District:** Banan
Commune: Kantueu Muoy **Village:**

Site notes: Typical black soil at base of limestone hills. Calcareous sub soil.

Disturbance: clearing

Current Classification
World Reference Base: (2006) Calcic Chernozem (clayic)
Local Soil Name: Kompong Siem, non gravelly phase

Soil Profile Description

Horizon	Depth (cm)	Description
Ap	0-20	very dark grey (10YR 3/1 moist) clay; strong, fine, granular structure.
B	20-80	dark grey (10YR 4/1 moist) clay; strong, medium, subangular blocky structure.
BC	80-110	dark greyish brown (10YR 4/2 moist) clay.
C	110-140	white (10YR 8/2 moist).

Project & Site Code: ACIAR 0066 **Described by:** Schoknecht Noel
Date: 18/05/2005

Observation type/category: auger boring, observation

Location: Datum: IND60 Zone: 48 292892 mE 1424405 mN GPS measurement

Province: BATTAMBANG **District:** Banan
Commune: Chaeng Mean Chey **Village:** Thngor

Site notes: Beside road. Shallow pit + core auger sampling
Disturbance: irrigation unspecified

Landform
Landform element: flood plain *Landform pattern:* alluvial plain
Relief/modal slope: plain *Slope class:* level, 0.2-0.5%
Morphological type: Bottom (drainage line) *Slope curvature:* straight
Microrelief: even

Vegetation
Crop: rice
Notes: Cleared- Scattered mango and neem trees.

Land use
Site: rainfed arable cultivation *Surrounds:* rainfed arable cultivation

Current Classification
World Reference Base: (2006) Vertisol
Local Soil Name: Toul Samroung, brown phase

Soil Profile Description

Horizon	Depth (cm)	Description
Ap	0-15	brown (10YR 4/3 moist) clay; few fine faint yellowish brown (10YR 5/6 moist) mottles; strong, very fine, subangular blocky structure; few segregations, fine iron-manganese (sesquioxides) concretion rounded hard.
B	15-90+	pale brown (10YR 6/3 moist) clay; common fine distinct yellowish brown (10YR 5/6 moist) mottles; few segregations, fine iron-manganese (sesquioxides) concretion rounded hard.

Project & Site Code: ACIAR 0067 **Described by:** Schoknecht Noel
Date: 18/05/2005

Observation type/category: Soil Pit, Full description

Location: Datum: IND60 Zone: 48 292000 mE 1425336 mN GPS measurement

Province: BATTAMBANG **District:** Banan
Commune: Chaeng Mean Chey **Village:** Thngor

Site notes: Gentle footslope below hills.

Landform
Microrelief: even

Vegetation
Crop: peanut (groundnut)

Current Classification
World Reference Base: (2006) Haplic Vertisol
Local Soil Name: Toul Samroung, brown phase

Soil Profile Description

Horizon	Depth (cm)	Description
Ap	0-10	dark greyish brown (10YR 4/2 moist) clay; no mottles; firm moderately moist consistence; moderate, very fine, subangular blocky structure; common segregations, very fine manganese (manganiferous) concretion rounded black hard; non-cemented and non-compacted; clear boundary.
A	10-50	yellowish brown (10YR 5/4 moist) clay; few fine faint yellowish brown (10YR 5/6 moist) mottles; firm moist consistence; moderate, medium, subangular blocky structure; common segregations, fine manganese (manganiferous) concretion rounded black hard; non-cemented and non-compacted; gradual boundary.
B	50-90	weak red (2.5YR 4/2 moist) heavy clay; few fine faint yellowish brown (10YR 5/6 moist) mottles; very firm moist consistence; strong, coarse, angular blocky structure; smooth-ped fabric; few segregations, fine manganese (manganiferous) concretion rounded black hard; non-cemented and non-compacted; gradual boundary.
BC	90-100+	brown (10YR 4/3 moist) clay; few fine faint yellowish brown (10YR 5/6 moist) mottles; firm moist consistence; weak, medium, subangular blocky structure; few segregations, fine manganese (manganiferous) concretion rounded hard; non-cemented and non-compacted.

Project & Site Code: ACIAR 0069 **Described by:** Schoknecht Noel
Date: 18/05/2005

Observation type/category: soil pit, observation

Location: Datum: IND60 Zone: 48 281192 mE 1426337 mN GPS measurement

Province: BATTAMBANG **District:** Rotanak Mondol
Commune: Sdau **Village:**

Site notes: Brown loam surface grading to yellow clay. Sandstone rock in pit. WRB: Agrisol or Regosol. Very gentle slopes surrounding hills.

Landform
Landform element: slope *Relief/modal slope:* level land
Slope class: nearly level, 0.5-1% *Morphological type:* lower slope
Slope curvature: straight

Geology/parent material
Soil parent material: colluvial
Geology: sandstone, greywacke, arkose
Notes: sandstone

Current Classification
World Reference Base: (2006) Haplic Lixisol
Local Soil Name: No equivalent

Soil Profile Description

Horizon	Depth (cm)	Description
	0-25	dark brown (7.5YR 3/2 moist) loam; moist soil; weak, fine, subangular blocky structure; gradual boundary.
	25-80	yellowish brown (10YR 5/6 moist) clay; common fine faint dark greyish brown (10YR 4/2 moist) mottles; moderate, medium, subangular blocky structure.
	80+	

Project & Site Code: ACIAR 0070 **Described by:** Schoknecht Noel
Date: 18/05/2005

Observation type/category: soil pit, full description

Location: Datum: IND60 Zone: 48 287143 mE 1434700 mN GPS measurement

Province: BATTAMBANG **District:** Banan
Commune: Snoeng **Village:** Peak Sbaek

Site notes: Similar to Prateah Lang soil group, although heavier and weakly structured in top soil
Disturbance: ploughing

Landform
Landform pattern: alluvial plain *Relief/modal slope:* plain
Slope class: level, 0.2-0.5% *Slope type:* intermediate part
Microrelief: even

Surface and Hydrological Properties
Rock outcrop: no rock
Surface coarse fragments: no gravel or stones
Physical properties: hardsetting surface; cryptogam surface; 100-150 cm soil

Geology/parent material
Soil parent material: Fluvial

Land use
Site: rainfed arable cultivation *Surrounds:* rainfed arable cultivation

Vegetation
Crop: Rice

Current Classification
World Reference Base: (2006) Plinthic Acrisol
Local Soil Name: Prateah Lang, clayey subsoil phase

Project & Site Code: ACIAR 0070 **Described by:** Schoknecht Noel
Date: 18/05/2005

Soil Profile Description

Horizon	Depth (cm)	Description
A1p	0-40	light brown (7.5YR 6/4 moist), pinkish grey (7.5YR 7/3 dry) sandy loam; many fine distinct reddish yellow (7.5YR 6/6 moist) redox mottles; hard dry consistence; weak, medium, subangular blocky structure; few segregations, fine iron-manganese (sesquioxides) concretion rounded brown hard; few roots, fine non-cemented and non-compacted; no coarse fragments; clear, smooth boundary.
A2	40-75	light brown (7.5YR 6/4 moist), pinkish grey (7.5YR 7/2 dry) sandy clay loam; common medium distinct red (10R 4/6 moist) mottles; hard dry consistence; moderate, medium, subangular blocky structure; no roots, non-cemented and non-compacted; no coarse fragments; clear, smooth boundary.
B1t	75-100	pinkish grey (7.5YR 6/3 moist) light clay; common medium distinct brownish yellow (10YR 6/6 moist) mottles; very hard dry consistence; moderate, coarse, subangular blocky structure; no roots, non-cemented and non-compacted; no coarse fragments; abrupt, smooth boundary.
B2t	100-145+	pale brown (10YR 6/3 moist) light clay; many coarse distinct reddish yellow (7.5YR 6/6 moist) redox mottles; firm moist consistence; weak, coarse, subangular blocky structure; common segregations, fine manganese (manganiferous) soft segregation elongated soft; no roots, non-cemented and non-compacted; no coarse fragments.

Project & Site Code: ACIAR 0072 **Described by:** Schoknecht Noel
Date: 19/05/2005

Observation type/category: soil pit, full description

Location: Datum: IND60 Zone: 48 286286 mE 1465434mN GPS measurement

Province: BATTAMBANG **District:** Thma Koul
Commune: Bansay Traeng **Village:** Thmei

Site notes: Pit in paddy fields. Vertisol cracks throughout profile. Brown phase of Toul Samrong soil group. Cracking at least 5 mm wide
Disturbance: ploughing

Landform
Landform pattern: alluvial plain
Relief/modal slope: plain
Slope class: flat

Surface and Hydrological Properties
Rock outcrop: no rock
Surface coarse fragments: no gravel or stones
Physical properties: cracking surface; >150 soil

Geology/parent material
Soil parent material: Fluvial
Notes: alluvium

Vegetation
Crop: Rice

Land use
Site: rainfed arable cultivation *Surrounds:* rainfed arable cultivation

Current Classification
World Reference Base: (2006) Haplic Vertisol
Local Soil Name: Toul Samroung, brown phase

Project & Site Code: ACIAR 0072 **Described by:** Schoknecht Noel
Date: 19/05/2005

Soil Profile Description

Horizon	Depth (cm)	Description
A1p	0-7	light brown (7.5YR 6/4 moist) clay; few fine distinct reddish yellow (7.5YR 7/8 moist) mottles; friable moist consistence, plastic; strong, fine, subangular blocky structure; no segregations; many roots, fine; no coarse fragments; sharp, smooth boundary.
A2	7-26	pinkish grey (7.5YR 6/2 moist) clay; many fine distinct strong brown (7.5YR 5/6 moist) redox mottles; hard dry consistence; strong, medium, subangular blocky structure; no segregations; many roots, fine; no coarse fragments; sharp, wavy boundary
A3	26-80	light brownish grey (10YR 6/2 moist) clay; many fine faint brown (7.5YR 4/3 moist) redox mottles; very hard dry consistence; very coarse, angular blocky structure; no segregations; few roots, fine; no coarse fragments; gradual, wavy boundary.
C	80-110+	grey (10YR 5/1 moist) heavy clay; common fine distinct yellowish brown (10YR 5/4 moist) redox mottles; firm moist consistence; very coarse, subangular blocky structure; no segregations; few roots, fine; no coarse fragments.

Project & Site Code: ACIAR 0074 **Described by:** Schoknecht Noel
Date: 19/05/2005

Observation type/category: soil pit, full description

Location: Datum: IND60 Zone: 48 235865 mE 1451665 mN GPS measurement

Province: BATTAMBANG **District:** Kamrieng
Commune: Ou Da **Village:** Tang Yu

Site notes: Soil of Colluvial origin in small quarry. Colluvium looks like carbonate nodules. Like Labansiek soil group on carbonate colluvium
Disturbance: borrow pit

Landform
Landform element: slope *Relief/modal slope:* low-gradient footslope
Slope class: gently sloping 2-5% *Slope curvature:* convex
Microrelief: even

Surface and Hydrological Properties
Physical properties: self-mulching surface; well drained; 25-50 cm soil

Geology/parent material
Soil parent material: colluvial

Vegetation
Crop: Maize

Land use
Site: Maize *Surrounds:* Maize

Current Classification
World Reference Base: (2006) Calcisol
Local Soil Name: Labansiek, no phase specified (notes: shallow calcareous)

Soil Profile Description

Horizon	Depth (cm)	Description
A	0-20	dark reddish brown (5YR 3/3 moist) clay loam; no mottles; friable moist consistence; strong, fine, granular structure.
AC	20-45	reddish brown (5YR 4/4 moist) clay; no mottles; very friable moist consistence; strong, fine, granular structure; many coarse fragments subrounded coarse gravel colluvial.
C1	45-70	reddish yellow (5YR 7/6 moist); no mottles; friable moist consistence; abundant coarse fragments subrounded coarse gravel colluvial.
C2	70-120+	; no mottles; firm moist consistence; weakly cemented, nodular, carbonates continuous pan; subrounded coarse gravel colluvial.

Project & Site Code: ACIAR 0075 **Described by:** Hin Sarith
Date: 20/05/2005

Observation type/category: soil pit, full description

Location: Datum: IND60 Zone: 48 233847 mE 1450724 mN GPS measurement

Province: BATTAMBANG **District:** Kamrieng
Commune: Ou Da **Village:** Lumphat

Site notes: Closest soil group is Toul Samroung. Deep cracks still seen although some rain has fallen.
Disturbance: clearing

Landform
Landform pattern: alluvial plain
Relief/modal slope: plain
Slope class: level 0.2-0.5%
Microrelief: even

Vegetation
Crop: Sesame

Land use
Site: rainfed arable cultivation *Surrounds:* rainfed arable cultivation

Current Classification
World Reference Base: (2006) Vertisol
Local Soil Name: Toul Samroung, brown phase

Soil Profile Description

Horizon	Depth (cm)	Description
A1p	0-18	brown (10YR 4/3 moist) clay; slightly hard moist consistence; moderate, fine, subangular blocky structure; no segregations; many roots, fine, non-cemented and non-compacted; no coarse fragments; medium porosity void; abrupt, smooth boundary.
A2	18-60	brown (7.5YR 5/3 moist) heavy clay ; common fine distinct yellowish brown (10YR 5/6 moist) mottles; very hard dry consistence; moderate, coarse, subangular blocky structure; no segregations; few roots, fine, non-cemented and non-compacted; no coarse fragments; low porosity void; clear, smooth boundary.
C	60-100+	dark grey (10YR 4/1 moist) heavy clay; no mottles; very firm moderately moist consistence; strong, coarse, angular blocky structure; no segregations; no roots, non-cemented and non-compacted; no coarse fragments; low porosity void.

Project & Site Code: ACIAR 0076 **Described by:** Hin Sarith
Date: 20/05/2005

Observation type/category: soil pit, full description

Location: Datum: IND60 Zone: 48 219871 mE 145673 mN GPS measurement

Province: BATTAMBANG **District:** Kamrieng
Commune: Ta Saen **Village:** Ou Chamlang

Site notes Farmer advised that Thai soil experts had done some field work in area (about 2003)

Disturbance: ploughing

Landform
Landform element: slope
Relief/modal slope: low-gradient footslope
Slope class: very gently sloping, 1-2%
Microrelief: low gilgai

Surface and Hydrological Properties
Physical properties: cracking surface

Geology/parent material
Soil parent material: silt-, mud-, claystone

Vegetation
Crop: beans

Land use
Site: rainfed arable cultivation *Surrounds:* rainfed arable cultivation

Current Classification
World Reference Base: (2006) Vertisol
Local Soil Name: Kompong Siem, non gravelly phase

Project & Site Code: ACIAR 0076 **Described by:** Hin Sarith
Date: 20/05/2005

Soil Profile Description

Horizon	Depth (cm)	Description
Ap1	0-13	dark brown (10YR 3/3 moist) clay; no mottles; hard dry consistence; moderate, fine, subangular blocky structure; very few segregations, fine carbonates (calcareous) irregular white hard; common roots, fine, non-cemented and non-compacted; very few coarse fragments rounded large boulders; sharp, smooth boundary.
A2	13-38	brown (10YR 5/3 moist) heavy clay; no mottles; very hard moderately moist consistence; moderate, coarse, subangular and angular blocky structure; common segregations, fine carbonates (calcareous) nodule irregular white hard; few roots, fine, non-cemented and non-compacted; gradual, wavy boundary.
A3	38-100+	brown (10YR 5/3 moist) heavy clay; no mottles; firm moist consistence; strong, very coarse, angular blocky structure; few segregations, medium carbonates (calcareous) nodule irregular white hard; no roots, non-cemented and non-compacted.

Project & Site Code: ACIAR 0077 **Described by:** Hin Sarith
Date: 20/05/2005

Observation type/category: soil pit, full description

Location: Datum: IND60 Zone: 48 216149 mE 1469171 mN GPS measurement

Province: BATTAMBANG **District:** Phnum Proek
Commune: **Village:**

Site notes structured black clay on limestone colluvium below limestone hill.
Disturbance: borrow pit

Landform
Landform element: slope *Relief/modal slope:* low-gradient footslope
Slope class: sloping 5-10%
Microrelief: uneven

Surface and Hydrological Properties
Rock outcrop: 2-5% few limestone, other carbonate rock
Surface coarse fragments: stones (>60 mm), 15-40%, subrounded, limestone, other carbonate rock.
Physical properties: self-mulching surface; somewhat excessively drained; 25-50 cm soil

Geology/parent material
Soil parent material: limestone, other carbonate rock
Geology: limestone, other carbonate rock
Notes: limestone

Vegetation
Crop: mung bean

Land use
Site: rainfed arable cultivation *Surrounds:* rainfed arable cultivation

Current Classification
World Reference Base: (2006) Chernozem
Local Soil Name: Kompong Siem, non gravelly phase

Project & Site Code: ACIAR 0077 **Described by:** Hin Sarith
Date: 20/05/2005

Soil Profile Description

Horizon	Depth (cm)	Description
A1	0-25	very dark grey (7.5YR 3/1 moist) clay; slightly hard dry consistence; strong, medium, granular structure; few coarse fragments subrounded coarse gravel limestone, other carbonate rock; clear, smooth boundary.
A2	25-50	very dark grey (7.5YR 3/1 moist) clay; slightly hard moderately moist consistence; strong, medium, granular structure; few coarse fragments subrounded coarse gravel limestone, other carbonate rock; abrupt, smooth boundary.
AC	50-120+	light yellowish brown (10YR 6/4 moist); slightly hard moist consistence; few coarse fragments subrounded coarse gravel limestone, other carbonate rock.; slightly hard consistence.

Table 1. Results of laboratory analysis of soil profiles – Nutrients.

Site	Location	Cambodian Soil Type		Depth	Nitrogen			Phosphorous	Potassium	Sulphur	Copper	Zinc	Manganese	Iron	Boron
		Type	Phase		NO_3	NH_4^+	Total N	P	K	S	Cu	Zn	Mn	Fe	B
				(cm)	(mg/kg)	(mg/kg)	(%)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
31	Banan	Kompong Siem		0-8	12.0	7.0	0.12	18	142	4.1	1.29	0.4	7.97	5.11	0.4
				8-30	4.0	4.0	0.09	6	51	1.7	1.6	0.3	5.24	4.54	0.4
				30-45	7.0	2.0	0.06	3	42	1.4	1.76	0.21	3.12	5.81	0.3
				45+	1.0	1.0	0.02	3	17	1	0.44	0.19	1.28	1.05	0.2
33	Banan	Kompong Siem		0-3	11.0	8.0	0.15	18	247	17.8	3.15	0.7	11.16	9.48	0.3
				3-30	5.0	7.0	0.08	9	144	12.4	2.73	1.78	11.25	15.25	0.2
				30-60	1.0	3.0	0.03	2	53	32.3	1.11	0.11	4.22	2.74	0.1
				60-100	1.0	3.0	0.02	1	60	42.1	1.35	0.21	3.18	2.24	0.1
				100-110	1.0	2.0	0.02	2	106	23.8	0.81	0.31	2.91	2.84	0.1
34	Banan	Toul Samrong		0-10	6.0	8.0	0.1	7	124	3.9	2.31	0.72	207.95	60.91	0.3
				10-40	1.0	2.0	0.03	3	40	1.1	1.25	0.34	43.38	18.85	0.4
				40-80	1.0	4.0	0.03	2	50	1	1.25	0.45	34.99	12	0.3
				80-100+	1.0	3.0	0.02	1	62	1.1	1.41	0.48	28.46	11.91	0.2
42	Banan	Kiensvay		0-18	75.0	32.0	0.1	22	174	11.4	2.4	1.32	35.43	38.44	0.4
				18-60	1.0	1.0	0.04	20	105	2.4	3.46	0.75	22.1	38.23	0.4
				60-100	1.0	1.0	0.04	10	95	1.6	1.89	0.83	16.45	3.44	0.4

Table 2. Results of laboratory analysis of soil profiles – Exchangeable cations.

Site	Location	Cambodian Soil Type		Depth	Calcium	Magnesium	Sodium	Potassium	Alumium
		Type	Phase		Ca	Mg	Na	K	Al
				(cm)	(meq/100g)	(meq/100g)	(meq/100g)	(meq/100g)	(meq/100g)
31	Banan	Kompong Siem		0-8	41.14	4.13	0.03	0.35	0
				8-30	44.18	0.96	0.04	0.14	0
				30-45	38.95	0.39	0.03	0.13	0
				45+	16.12	0.08	0.02	0.05	0
33	Banan	Kompong Siem		0-3	45.16	6.86	2.43	0.63	0
				3-30	40.93	7.94	5.95	0.4	0
				30-60	24.22	10.16	11.62	0.13	0
				60-100	17.25	14.86	18.28	0.15	0
				100-110	12.36	12.78	15.11	0.2	0
34	Banan	Toul Samrong		0-10	8.84	3.23	0.24	0.34	0
				10-40	5.1	1.48	0.64	0.08	2.02
				40-80	10.2	6.87	2.77	0.14	2.09
				80-100+	13.67	9.01	3.34	0.19	0.19
42	Banan	Kiensvay		0-18	12.13	5.71	0.26	0.4	0
				18-60	16.39	8.14	0.18	0.3	0.02
				60-100	19.88	7.79	0.17	0.3	0

Table 3. Results of laboratory analysis of soil profiles - Organic Carbon, Electrical Conductivity and pH.

Site	Location	Cambodian Soil Type		Depth	Organic Carbon	EC	pH	pH
		Type	Phase				$CaCl_2$	H_2O
				(cm)	(%)	(dS/m)		
31	Banan	Kompong Siem		0-8	1.3	0.11	7.2	8.2
				8-30	0.9	0.063	7.3	8.3
				30-45	0.6	0.087	7.6	8.6
				45+	0.19	0.059	7.7	9
33	Banan	Kompong Siem		0-3	1.81	0.304	7.6	8.5
				3-30	0.89	0.272	7.9	9.1
				30-60	0.34	0.516	8.3	9.6
				60-100	0.33	0.491	8.4	10.1
				100-110	0.2	0.758	8.6	9.9
34	Banan	Toul Samrong		0-10	1.17	0.032	4.5	5.5
				10-40	0.34	0.009	4.2	6.3
				40-80	0.3	0.013	4.3	6.6
				80-100+	0.24	0.047	5.2	6.8
42	Banan	Kiensvay		0-18	1.1	0.175	5.6	6
				18-60	0.52	0.018	5.3	6.5
				60-100	0.41	0.023	6.3	7.4

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